APPLICATION

FOR

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TITLE: 22K GOLD ALLOY COMPOSITIONS

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22k Gold Alloy Compositions

Reference to Provisional Application

This application is entitled to the benefit of earlier filed provisional application, serial number 60/229,773, filed on September 1, 2000 pursuant to 35 U.S.C. § 119 (e)(1).

Field of the Invention

This invention is in the general field of gold alloys and is concerned more particularly with a range of novel 22karat gold alloy formulations.

Background of the Invention

The quality of gold jewelry typically ranges from 8 to 24 karat. Eight and nine karat gold alloys have minimal corrosion resistance, even in the best of a limited group of formulations. The limited corrosion resistance and laws ("plumb laws") of many countries requiring a minimum of 10k (41.67% gold) for jewelry to be stamped with a karat mark limit the popularity of these compositions.

In western countries 10k, 14k and 18k golds are the most popular karats for reasons of custom, cost and flexibility in color and metallurgical properties. In the 10-18k range of alloys, the proportion of non-gold elements is sufficiently high that varying the type and percentage non-gold elements permits customization of properties such as hardness, elongation, grain size, etc., while maintaining sufficiently high gold content for corrosion resistance

At the highest levels of gold quality, 22k, near 24k and 24k (Chuk Kam) are used to fabricate traditional styles of jewelry in India, China, Thailand and elsewhere in South East Asia. While traditional alloys exhibit a pleasing yellow color and excellent corrosion resistance, their metallurgical properties, such as hardness, are such that the

jewelry must be made substantially thicker (and thus heavier) since these alloys are very soft in comparison with the lower karat formulations. Pieces in these karats typically are limited to simple, heavy designs.

Traditional 22k compositions are comprised of gold, silver, copper and occasionally low levels of zinc. Modern jewelry fabrication techniques, such as machine fabrication of springs for clasps, threaded earring posts from drawn wire and like materials, are critical to modern jewelry designs. Such techniques are difficult, if possible at all, using standard 22k formulations because such techniques require alloys that have properties similar to those of 18k or 14k.

In general alloy characteristics for jewelry fabrication result in a compromise of desired characteristics. For example, a 22k alloy of the best color might be too soft for chain fabrication. Therefore, an alloy of less desirable color and greater hardness is substituted as a compromise.

Several 22k formulations are provided below designated as alloys 82-86 in Sterner-Rainer, Die Edelmetall-Legierungen in Industrie und Gewerbe, Verlag von Wilhelm Diebener G. m.b.H., Leipzig, Germany (1930), pp. 109-110.

See also U.S. 4,987,038.

Alloy	Color	% Gold	% Silver	% Copper	Brinell Hardness (Hb) % reduction 0%	15%	30%	60%
82	orange-yellow	91.67	0.00	8.33	66	127	139	155
83	dark yellow	91.67	2.08	6.25	64	115	124	140
84	golden	91.67	4.16	4.16	57	101	110	123
85	light yellow	91.67	6.25	2.08	48	86	94	105
86	green-yellow	91.67	8.33	0.00	30	56	67	74

Traditional formulations that possess many of the critical metallurgical properties (for example dental alloys) may suffer from poor color and are not useful for jewelry usage.

Modern alloys using titanium as an additive in increase the hardness of 99% gold typically are not practical as they require special melting equipment and techniques used in electronic materials operations and are not generally found in jewelry factories.

It is therefore the object of this invention to produce novel formulations for 22K gold alloys that possess the traditional yellow color of high karat gold alloys while maintaining a compromise of desired metallurgical properties similar to those of popular lower karats. Such formulations can be used to fabricate relatively light weight, complex jewelry components using traditional melting and fabrication techniques as well as modern machine methods while maintaining the 22K gold quality and colors.

Summary of the Invention

The new alloys according to my invention have the following general composition by weight:

gold: 89.5%-93.75%;

silver: 2 –6% (and preferably 2-5%)

cobalt: 0.1 to 2% (and preferably 0.1 – 1%)

boron (optional) up to 0.5%

copper: 0.33-8.40%

This 22k alloy is made by combining gold with a master alloy having a composition as follows:

silver: 32 –96%

cobalt: 1.6-32.00%

boron (optional) up to 8%

copper: : 5.28 – 66.40%.

This unique combination of these elements yields 22k alloys meeting modern jewelry fabrication techniques requirements and exhibiting pleasing yellow color. The new alloys are stable under normal use and do not appreciably tarnish. They also have substantially no discoloring effect on the skin. These formulations possess work hardening properties consistent with gold alloys of lower karat while maintaining color properties consistent with traditional 22k gold jewelry.

Other features and advantages of the invention will be apparent from the following description of the Preferred Embodiments, from the Figures and from the claims.

Brief Description of the Drawing

Fig. 1 is a graph depicting the results of comparative studies described below.

Perferred Embodiments

The alloy components are carefully selected and formulated. Important characteristics of a gold alloy to be used for jewelry fabrication are as follows:

(1) Color: The color of the alloy should be cosmetically appealing and consistent with the karat. That is, higher karat alloys are expected to be more yellow than lower karats.

(2) Hardness vs. % Reduction in Thickness: The alloy should respond at a reasonable and consistent rate to a reduction in thickness. That is, as the alloy is rolled, the hardness should increase to a near maximum hardness at around 60-70% reduction in thickness. Alloys that require rolling to greater than 70% to achieve maximum hardness are likely to suffer from a variety of irreversible grain structure problems yielding a poor quality product.

(3) Minimum Hardness: Most gold alloys measurably increase in hardness as the thickness is reduced. While this characteristic provides the manufacturer the opportunity to make a product of at any hardness value from the fully annealed (softest state) to the "full hard" (hardest state), the semi-finished or finished jewelry piece is likely to be softened during a production or repair soldering operation. For example, should a finger ring of 22k gold manufactured at the appropriate hardness require repair, a soldering operation will in effect fully anneal adjacent sections or the entire piece to a very soft state that is likely to result in an unacceptably weak piece of jewelry.

(4) Reuse: Contaminated or partially oxidized 22k gold jewelry alloys are by the nature of their composition relatively expensive refine into pure gold. Thus an alloy should survive several re-meltings without serious loss of product quality. Otherwise, routine scrap recycling costs will make the composition impractical.

(5) Special Melting Equipment: 22k gold jewelry is produced around the world in wide variety of production settings. Factory equipment for melting and casting ranges from high-powered electric melting furnaces to the much more common method of melting with a propane/oxygen brazing torch. An alloy useful for the jewelry industry should be suitable for the entire range of melting operations. Alloys that require high cost vacuum melting units or extremely low levels impurities to work effectively are not useful for the vast majority of jewelry manufacturers.

(7) Toxic elements: Jewelry is often worn against the skin and is subject to a wide range of mechanical, chemical and temperature conditions. Element additions which might be effective in improving 22k gold characteristics in a semi-conductor application may not be suitable for jewelry use. As an example, due to the adverse dermatologic events associated with nickel in gold jewelry, laws severly restrict the sale of gold jewelry containing that element in the EEC.

Lower silver-bearing compositions are slightly reddish and the higher silver compositions are slightly green. In addition to changing the alloy color, increasing the silver decreases the hardness of the work-hardened state as demonstrated below:

	ALLOY 1	ALLOY 2	ALLOY 3	ALLOY 4
GOLD	91.67%	91.67%	91.67%	91.67%
SILVER	0%	1%	3%	5%
COBALT	0.73%	0.73%	0.073%	0.073%
BORON	0.02%	0.02%	0.02%	0.02%
COPPER	7.58%	6.58%	4.58%	2.58%
COLOR	pink/yellow	pale pink/yellow	Yellow	green/yellow
HARDNESS*	168	153	136	122

(*) Brinell Hardness (Hb) following a 61% reduction in the cast bar thickness

Cobalt in conjunction with boron creates a desirable fine-grained structure in both the work hardened and fully annealed states. Boron also sharply decreases the rate of copper oxidation during melting by preferentially combining with oxygen over copper thus increasing the number of times the alloy may be reused prior to chemical refining. In comparison to the same alloy without boron, the boron containing formulation has increased fluidity at temperatures above the melting point. Thus, casting operations can be conducted a lower temperatures than comparable 22k alloys. Increased molten alloy fluidity also facilitates the casting of intricate designs. Copper increases the hardness of the alloy while without bleaching the desirable yellow gold color. All elements of the new compositions are standard to the industry. Each of the elements is safely used in jewelry alloys.

An example of the new alloy formulations is as follows:

SAMPLE ALLOY ACCORDING TO THE INVENTION

Color	% Gold	% Silver	% Cobalt	% Boron	% Copper	Brinell Hardness (Hb) % reduction						
						0%	15%	30%	60%	70%	75 %	80%
golden yellow	91.67	4.00	0.40	0.025	3.095	83	99	116	134	136	138	138

Fig. 1 is a graph comparing the above sample alloy to known alloys 82 –86 described in the Background, above. The inventive 22k gold alloy has the following desirable characteristics compared to alloys 82 –86 described in the Background, above :

(1) The new alloy color is described as golden yellow versus orange-red, dark yellow, light yellow and green-yellow for alloys 82 through 86 respectively. Alloys 82, 83, 85 and 86 have colors generally unacceptable to the jewelry industry.

(2) The Hardness vs. % Reduction curve of the new alloy example demonstrates:

a. The minimum hardness (fully annealed state) is significantly higher than the comparable formulation as well each of the other classical formulations.

b. The hardness of the new alloy increases at a reasonable rate over an estimated 60% reduction in thickness.

c. The hardness at 60% reduction is significantly higher than the hardness of the comparable formulation.

d. (Not shown) The maximum alloy hardness is reached at about 60% reduction in thickness. (70% Reduction: Hb=136, 75% Reduction: Hb=138 85% Reduction: Hb=138)

Alloys according to the invention generally may be melted and worked by any of the methods and techniques known in the art of making articles of jewelry of 10-18K. They lend themselves readily to casting operations and may be repeatedly re-cast and re-alloyed without suffering loss of quality. These alloys may be subjected without difficulty to working methods such as wire drawing, punching and stamping.

Without departing from the spirit of the invention, alloys as described may be improved by the addition of small quantities of further elements, for instance, silicon or phosphorous up to 0.2% if the primary usage is investment casting. Thus, the addition of 0.05% silicon will improve the surface of investment cast pieces by creating a silicon oxide barrier between the solidified investment powder and the molten gold alloy.

1. A 22K alloy such as the above sample alloy containing 91.67% gold, 4.00% silver, 0.40% cobalt, 0.025% boron and the remainder copper can be continuous cast into bars or rods. The bars can be repeatedly reduced by up to 70% in thickness and softened by annealing at 1250F by traditional fabrication and annealing techniques. Such bars can be reduced to any desired thickness. By adjusting the reduction percentage from the final annealed state thickness to the desired final rolled thickness, any Brinell (Hb) hardness value from 83 to 134 can be achieved.
2. Using the alloy composition in (1), 22K cast cylindrical rods can be rolled and drawn into 0.0361" diameter round wire. Such wire drawn to a Brinell hardness greater than 130 can machine fabricated into high quality threaded or friction-backed earring posts. Previously, earring posts of such small diameter have been difficult or impossible to make using traditional 22K compositions. Posts of this type have been reserved for harder, lower karat alloys.

In general, the best procedure for making up the alloys of the present invention is first to make a master alloy containing all of the constituent elements, except gold. The master alloy compositions are calculated from gold alloy formulations so that when pure gold is added to the master alloy in a ratio to yield a particular karat, the components of

the master alloy dilute to effective metallurgical concentrations. The master alloy is actually a karat gold formulation without the gold. Pure gold is added at the time of melting. Master alloys allow manufacturers to inventory relatively low cost compositions which are ready for use with only the addition of pure gold.

Sample Master Alloy

A 22K gold alloy and the calculated master alloy

	22K Gold Alloy "A"	Master Alloy for 22K Gold Alloy "A"
Gold	91.67%	0.00%
Silver	5.00%	60.02%
Cobalt	0.73%	8.76%
Boron	0.02%	0.24%
Copper	2.58%	30.98%

What is claimed is: